THE OHIO JOURNAL OF SCIENCE

VOL. XXVIII SEPTEMBER, 1928 No. 5

NOTES ON THE HABITS OF APHIOCHAETA ALETIÆ.

W. V. BALDUF.*

Department of Entomology, University of Illinois.

A somewhat detailed account of observations on the habits and development of a member of the dipterous family Phoridæ may be pardoned in view of the impression given in the literature that little is known of the activities of these flies. In his study of corn insects in Ohio, Dr. C. R. Neiswander has in the past few years, found specimens of the spindle stalk-borer (*Achatodes zeæ* Harris), a noctuid, in corn stalks. In the season of 1927, he took it very commonly in elder. On June 24, Dr. Neiswander showed the writer some larvæ of a hymenopterous parasite issuing from the backs of this borer. Incidental to observations on this parasite during the rest of the summer, the writer found three other species of insects, two dipterous forms, and one other hymenopterous species attacking these caterpillars. To date, December 1927, only one adult insect has appeared from the accumulated parasite material. This has been indentified as *Aphiochaeta aletiæ* Comst. of the dipterous family Phoridæ,† and it is the remarkable habits of this species that constitutes the occasion for this paper.

SUMMARY OF THE LITERATURE ON PHORIDÆ.

In his paper on this family, Malloch (1) states "that very little is known about their larval habits". . . . . ."Those that have been reared have been for the most part upon fungi, or upon dead decaying animal or vegetable matter. Some species have been reared from snails and a few from the bodies

*Contribution No. 121 of the Entomological Laboratories of the University of Illinois.

†The writer hereby expresses his indebtedness to Dr. J. M. Aldrich for determining the fly.

of bees, ants, or beetles, but whether the whole of these species were true parasites or not is a matter for conjecture. Several species are myrmecophilous." Malloch then (pp. 412-413) gives a list of some species whose habits are more or less known.

A survey of the economic literature on Phoridæ as given in the Review of Applied Entomology, Series A and B since 1913 when Malloch's paper appeared, demonstrates even further variety in the family habits. Morris (2) reared *Hypocera incrassata* Mg. from nearly full grown larvæ of *Bibio marci* that were unhealthy or dead after two weeks in the laboratory. He regarded this as a case of parasitism "being the first definite record of an insect parasitic on Bibionid larvæ." Wildermuth (3) records *Aphiochaeta perdita* from the pupæ of the alfalfa caterpillar (*Eurymus eurytheme*), and, inasmuch as the chrysalids were alive when collected, believes that "the flies could not be acting as scavengers, but must have been true parasites." *Aphiochaeta* sp. is listed by Snow (4) as a parasite of the cutworm, *Euxoa auxiliaris* Grote. The larvæ "were first seen actively moving around in" two cutworms, and fifteen adults issued from one of these. Ainslie and Cartwright (5) working with the lotus borer (*Pyrausta penitalis* Grote), obtained *Aphiochaeta chaetoneura* Mall., but state that they "were undoubtedly scavengers" because sound larvæ or pupæ were not attacked, and they lived equally well on putrid vegetable matter." The larvæ of various lady-beetles (6) are attacked by *Aphiochaeta fasciata* Fall. in France. In Mexico, Nocedo (7) records *A. scalaris* Lw. as a newly found parasite of *Schistocerca peregrina*, while Oberstein (8) in Germany, found many larvæ of *Phora rufipes* Meig. attacking swollen seeds and young seedlings of Woll-Luzerne.

In the field of medical entomology are habits as follows: Roberg (9) obtained nine phorid species from decaying animal matter, none of which were *Aphiochaeta*. *Aphiochaeta ferrugines* was found by him to be the commonest of flies breeding in human faeces, and evidence shows this species to be a possible carrier of Asiatic cholera and, by analogy, other alimentary infections. The same species (*A. Scalaris* Tw. = *A. ferruginea* Brunetti) develops in decaying meat according to Fletcher (10), and Spooner (11) found it in milk which suggested to him the possibility that this is the source of the larvæ which have caused myiasis of the human intestine. The same writer cites records of its occurrence on onions in the West Indies,

in decaying insects in Brazil, and as a parasite of *Hyphantria cunea* in Florida. Cases of cutaneous myiasis in man and animals, involving *A. xanthina* Speis. and *A. rufipes* Mg. in India, are described by Patton. This writer (13) later reports *A. xanthina* bred from dung of horses, cats and dogs, from stale and decaying meat, and from dead insects. The females will oviposit in sores.

The species of Phoridæ, and those of *Aphiochaeta* in particular, therefore have habits ranging from scavengers on plant and animal remains to true parasites on insects and higher animals. Most often, however, the object of attack gives evidence of decomposition in greater or lesser degree.

Aphiochaeta sp. from the Spindle Stalk-Borer.

Among the spindle stalk-borers collected on June 25, the writer noticed one individual that bore fifty small eggs on the back of the abdomen. No others carrying eggs in this way were found. The eggs were two-fifths of a mm. long and one-third as thick, with ends broadly rounded, and the surface smooth and whitish (Fig. 2). The parent fly had no definite scheme of depositing the eggs, but scattered them about miscellaneously here and there, this way and that, some lying upon others in a criss-cross manner.

Among the jumble of eggs were noticed several minute maggots awkwardly making slow progress hither and thither. Some stood up attached to the borer by the blunt end of their abdomens and explored the surroundings. Some maggots were still present on the back of the borer on June 26 and 27, and others had died there. Some died before hatching, but most eggs were empty. By June 28, all live maggots had disappeared from the back of the caterpillar. Where did they go, and what were they doing in connection with the borer? They did not penetrate the body as parasites. The borer was alive, and scarcely seemed to be a subject for attack of scavenger maggots.

The answer was found on June 28, when, by careful scrutiny of the caterpillar and its burrow in the elder stem, six maggots were seen in a cluster writhing over one another in a mass at the posterior end of the caterpillar. They were not attached to the borer. Further inspection revealed four more maggots of the same kind, but larger, moving about actively in the rectum of the borer. In a short time, these had disappeared

further into the lumen of the alimentary tract of the *Achatodes*, and in all subsequent observations, the maggots proved to have a strong negative light response. The anus of the borer was already widely and permanently distended. During the next week, daily examination showed that their occupancy of the rectal chamber was the true habit of the maggots in this case, and futhermore, they not infrequently left this cavity and reentered it, by way of the anus at all times. The body wall of the caterpillar was not broken by them. Almost daily, one or more of the maggots were seen outside of the caterpillar, and several times individuals were caught in the act of entering their habitation; or, if not conveniently located to enter the borer when their cage was opened, they took refuge under the borer's body. When the *Achatodes* lies in its normal position the anal aperture is almost flat on the floor of the burrow in the elder stem, which provides leverage for the maggots and makes entrance very convenient. The maggots also move more or less over the outside of the body, supported by the irregular surfaces of the segments.

The presence of the larvæ in the hind third of the body caused this portion to bulge out noticeably whenever they were inside the caterpillar. Only four of the maggots reached maturity. Most of the fifty were never seen. The borer had a tunnel a foot or more long extending from one internode to another. If it was able to crawl when the first maggots attacked it, this would suggest that many maggots died of starvation.

Development of the Fly.

Hatching seemed to be distributed over several days, and the eggs may have been deposited at different times. The egg shells clung to the borer as long as the latter was observed. Some larvæ had gone from the eggs on June 25, and half grown larvæ were seen on June 27. On the 25th, small larvæ still crept over the caterpillar. Growth was rapid. The days were the hottest of the summer. The larva stage required at least eleven days and probably not more than fifteen days. All the four surviving maggots had transformed to puparia by July 6, and the first puparium was seen on July 2. Upon maturity, the larvæ left the body of the borer and somehow secured themselves to various levels of the burrow of the caterpillar. Only one adult developed from the puparia even though they were kept moist constantly. This fly issued during the day of

July 13, and required between seven and eleven days to transform. The adult is restless, very active, able to run rapidly and travels also by short flights, and by jumping.

Food of the Aphiochaeta Larvæ.

In view of the common occurrence of the larvæ of an internal hymenopterous parasite in the spindle stalk-borers in June, it was thought possible that the *Aphiochaeta* larvæ might be devouring the parasites. But such Hymenoptera were apparently lacking. The maggots had not entered the body further than the posterior third. This region was found to be empty, the proctodaeum had been entirely reduced to an unrecongizable state, and only small amounts of fat body adhered to the inner surface of the body wall. Anterior to this region, the contents of the body were undisturbed and normally white. This situation showed that not the faeces of the caterpillar, but its store of adipose tissue was the chief source of food of the *Aphiochaeta* larvæ.

Relation of Aphiochaeta to the Spindle Stalk-Borer.

The borer was almost or quite full-grown and flabbid, when first seen on June 25, and scarcely moved from its original position while it lived—a period of seven days after its discovery. The body showed indications of disease—the anterior third of the body, and the last three abdominal segments being darkened; and the flabbid condition also pointed to this state. Other larvæ of this size were found entirely blackened, weakened and killed by a disease at the same time. Hence, the borer was probably quite feeble when the first maggots hatched. However, inasmuch as the maggots that were first seen in the rectum were about half grown, the status of the borer at the time they made their initial entrance is not positively known. But the occurrence of the disease is not in doubt, and this caterpillar may not be regarded as a normal individual. Some degree of putrefaction or similar phenomenon would seem to have been the influence that attracted the parent *Aphiochaeta* to it for oviposition. If parasitism be defined as existence of one or more organisms at the expense of one other normal individual, then *Aphiochaeta* was, in the present instance, a high grade scavenger, and not a true parasite. Inasmuch as diseases of lepidopterous larvæ and pupæ are common, and

because their presence is often not indicated externally until they have reached an advanced stage of development, it is plausible that most, if not all, instances of attack by Phoridæ may be upon organisms more or less debilitated by internal disorders.

Aphiochaeta sp. may not be considered as obligated to *Achatodes zeæ*, although its ability to find a borer in a stem with few openings indicates a keen sense if not a regular habit. This caterpillar pupates in June and July in old stems of the previous year's growth, and no more larvæ occur till the next

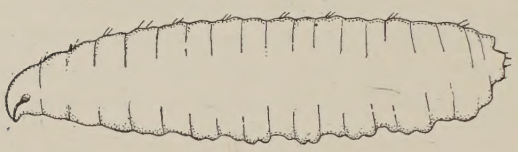


Fig. 1-19X

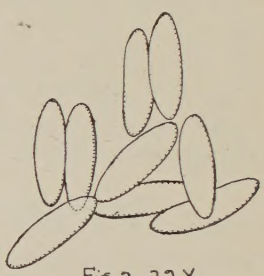


Fig. 2-32X

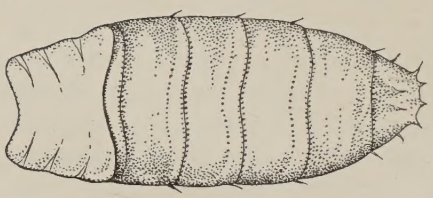


Fig. 3-24X

year. But the occurrence of another generation of *Aphiochaeta* is indicated by the development of an adult. It may be that an earlier as well as a later generation arises in the excreta of the borers, upon decaying organic matter or upon insects of an entirely different sort. If so, entrance to a source of food by way of the anus is not habitual, although extremely unusual, and broadens our present conception of the eccentricity and diversity of habit in the family Phoridæ.

Emergence of the Adult: Relationship.

In emerging, the adult removed entirely the terga of the first four segments, the sterna remaining intact and entire.

Hence, the aperture is not terminal, but dorso-terminal. Neither is it circular as in the calyptrate Diptera, but trapezoidal in shape. These features are not strictly cyclorrhaphous, but there is no suggestion of a straight or T-shaped seam, hence the relationship of the species is decidedly with the suborder Cyclorrhapha.

The adult (Fig. 4) is one and six-tenths mm. long, robust, with a prominent humped and somewhat spiny pronotum.

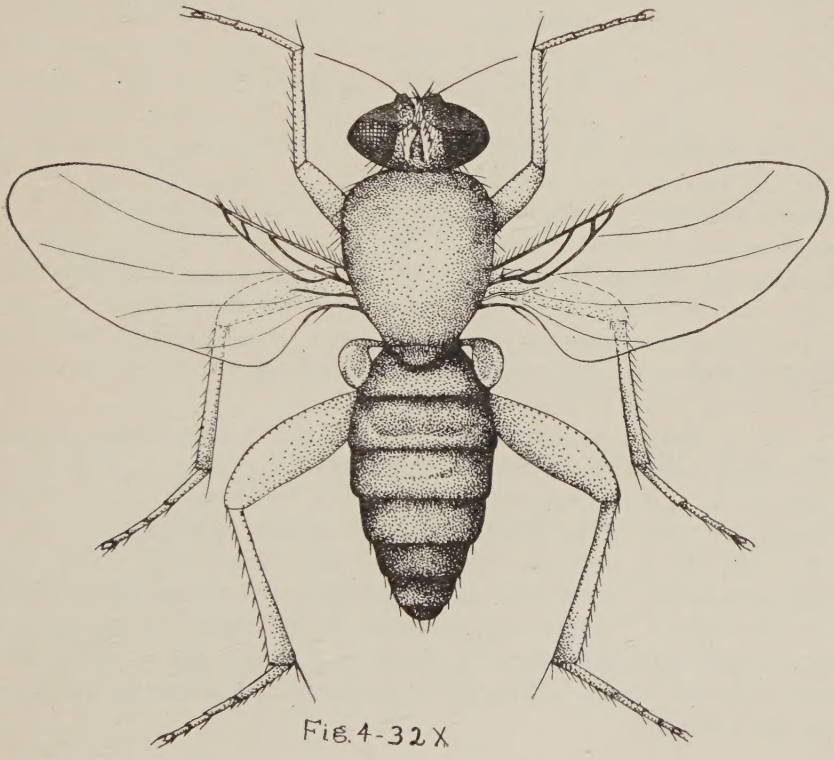


Fig. 4-32 X

The angular black eyes stand out conspicuously. The antennæ are globular and one-segmented, with a long arista bearing short fine pubescence. The thorax is brown, the first and third segments much reduced above, and the halteres are large and scale-shaped. On the basal half of the front margin of the wings is a row of stout hairs, and the venation is reduced to three longitudinal veins and two basal ones, to the distal one of which the longitudinal veins are attached. The legs are amber-colored at base, with dusky tibiæ and tarsi, and all

the femora are flattened and enlarged for jumping, those of the hind legs being the largest. The abdomen is black, seven-segmented, tapers posteriorly, and is strongly depressed.

Description of The Larva.

The larva (Fig. 1) is of the muscoid type with sub-conical body. All were entirely white except one that had several fine transverse rings of black segmentally on the front end of the body. The rings persisted until the maggot was full grown. Newly hatched individuals measure 1.09 mm. long, and the largest were 3.10 mm. in length. Viewed from above, fifteen pairs of lateral, cuticular, sharp conical processes, or hairs, arranged segmentally, are visible. On the posterior end is a slightly heavier pair of similar construction that forms a curved transverse row with the lateral pair of the last segment. On each segment are also a pair of humeral and two pairs of dorsal processes, like the lateral pair in size and form. The median dorsal pair arises near the front edge of the segments, the lateral pairs are median on the pleuron, and the other four of each segment form a crooked line with the others. No such structures occur on the venter.

Each dorsal segment consists of three transverse areas. The first, which bears the median dorsal processes, is as long as the third, and the second is two-thirds the length of either of the other two. The first is slightly and more sharply convex than the third, and the middle one lies lower than either the first or third. Three low rounded fleshy elevations are present on the sterna. They are arranged in triangles by segments, the third member situated anterior to the pair. A fourth and silmilar hump is located in front of the anterior member of the triangle.

Descriptions of the Puparium and the Adult.

The puparium (Fig. 3) is rich, light brown, and about two one-fifth mm. long, and has a maximum width of one mm., both ends being noticeably narrowed. The venter is moderately convex, and the dorsum somewhat more rounded. A prominent humeral ridge, rounded above, extends from end to end on each side. To these are united similar transverse segmental ridges.

LITERATURE CITED.

1. Malloch, J. R.
The Insects of the Dipterous Family Phoridæ in the United States National Museum. Proc. U. S. Nat. Mus., Vol. 43, pp. 411-531, 1913.

2. Morris, H. M.
On the Larva and Pupa of a Parasitic Phorid Fly *Hypocera incrassata* Mg. Parasitology Vol. 14, pp. 70-74, 1922.

3. Wildermuth, V. L.
The Alfalfa Caterpillar. U. S. Dept. Agr., Bul. 124, pp. 24-25, 1914.

4. Snow, S. J.
Observations on the Cutworm, *Euxoa auxiliaris* Grote, and its principal parasites. Jour. Eco. Ent., Vol. 18, pp. 602-609, 1925.

5. Ainslie, George J., and Cartwright, W. B.
Biology of the Lotus Borer (*Pyrausta penitalis* Grote). U. S. Dept. Agr., Bul. 1076, p. 12, 1922.

6. Martelli, G.
La *Thea 22-punctata* L. Giorn. Agric. Merid., VI, 1913, pp. 189-195. R. A. E., A, 1914.

7. Nocedo, C.
New Dipterous Parasites of the Locust, *Schistocerca peregrina*. Rev. Agric. Mexico, ii. pp. 132-135, 183-186, 1918.

8. Oberstein.
Phora rufipes in Experiments in Germinating Woll-Luzerne. Zeits. f. Pflanzenkrankheit, Stuttgart, Vol. 26, pp. 104-5, 1916.

9. Roberg, D. N.
I. The Role Played by the Insects of the Dipterous Family Phoridæ in Relation to the Spread of Bacterial Infections. II. Experiments on *Aphiochaeta ferruginea* Brunetti, with the Cholera vibrio. Phillippine Jour. Sci., 10, pp. 309-366, 1915.

10. Fletcher, T. B.
Rept. Imperial Pathological Entomologist. Scientific Repts. Agr. Research Institute, Pusa, f. 1916-1917.

11. Spooner, C. S.
An Interesting case of Milk Contamination. Jour. Eco. Ent., 13, pp. 368-9, 1920.

12. Patton, W. S.
Cutaneous Myiasis in Man and Animals in India. Indian Med. Gaz., Vol. 55, pp. 455-6, 1920.

13. Patton, W. S.
Notes on some Indian Aphiochaetæ. Indian Jour. Med. Res., Vol. 9, pp. 683-691, 1922.

THE CERIC ACID REACTION WITH PARTICULAR REFERENCE TO SUBERIN.*

R. C. THOMAS,
Ohio Agricultural Experiment Station.

INTRODUCTION.

The ceric acid reaction of Doepping (1) as later modified and defined by von Höhnel (4), is recognized by chemists to be a valuable test for the presence of suberin or cutin in plant tissue. This is because of the fact that none of the other cell wall constituents of plants when treated with a strong oxidizing mixture such as nitric acid and potassium chlorate yield similar products of oxidation. We do not know, however, what ceric acid, or the product of this so called ceric acid reaction, really is. It might be thought of as a definite compound, or as a mixture of the fatty acids of which suberin and cutin are composed. Under the first supposition one would naturally infer that the suberized and cuticularized portions of cell walls are very similar in composition. This assumption, however, would be at variance with experimental evidence presented by van Wisselingh (7). The object of this investigation of the product of the ceric acid reaction of suberin is to determine if this product is simply a mixture of the fatty acids of which suberin is known to be composed, and to endeavor to isolate and identify these respective acids.

HISTORICAL.

The ceric acid reaction was first reported by Doepping (1) in 1843. He obtained a substance which he called cerine, from the bark of the cork oak, *Quercus suber*, by extracting with alcohol or ether. The substance was crystalline, soluble in potassium hydrate and, when treated with concentrated nitric acid, a yellow or golden-yellow, wax-like product was obtained, to which the name ceric acid or cork wax was given. Doepping did not believe that all of the cerine could be extracted with alcohol or ether, because of the fact that bark, after extraction,

* Published with the approval of the Director of the Ohio Agricultural Experiment Station.

upon being treated with concentrated nitric acid, still yielded a substance similar in appearance and solubility reactions to ceric acid.

Von Höhnel (4), in 1877, modified the reaction by using nitric acid and potassium chlorate. He proposed this as a valuable test for the detection of both suberin and cutin, both substances yielding, when oxidized, oil-like globules which coalesced upon the surface of the liquid. He further characterized ceric acid as melting between 30° and 40°C. and soluble in boiling alcohol, ether, chloroform, benzol, and dilute potassium hydroxide. In von Höhnel's opinion there was no relation between cerine and ceric acid.

In his researches on the bark of the cork oak, Kügler (5) reported the presence of cerine, a higher alcohol, with a melting point of 250°F, stearic acid, phellonic acid, glycerine, and small quantities of coniferin and vanillin. The cork residue, after these substances had been extracted, did not yield ceric acid when oxidized. Van Wisselingh (7), using for the most part microchemical methods, detected both fusible and infusible substances present in the suberized walls of cork, and made special reference to phellonic acid. He considered suberin as a composite product of fatty acids or of analagous substances, such as ethers, glycerides, or compound ethers, and of one or more non-fusible substances, insoluble in chloroform, but which are decomposed by potassium hydroxide.

About the some time, Gilson (3), using the machrochemical methods of organic analysis, isolated three fatty acids, viz., phellonic, a white crystalline substance, melting at 95° to 96°C. suberic semi-liquid at ordinary temperatures and phloïonic crystallizing in white needles melting at 120° to 121°C. He also reported the presence of glycerine. In his investigations, the bark of the cork oak, *Quercus suber*, also of *Ulmus campestris*, var. suberosa, were used. In the latter, no phloïonic acid was found, and only a very small quantity in the former.

Gilson (3) considered suberin to be a mixture of compound ethers slightly fusible and insoluble in such solvents as alcohol, ether, and chloroform, or a product of combination, condensation, or polymerization of the acids or their derivatives. In this respect he was not in agreement with Kügler, who considered suberin to be a fat in the exact sense of the word.

After reviewing and confirming the work of Gilson, Priestly (6) states that we may consider suberin as an aggregate of

variously modified forms, possibly of condensation products or anhydrides of the acids present; also that the suberogenic acids are to a small extent combined with glycerine thus partaking of the nature of true fats.

In cutin, Fremy and Urbain (2) reported the presence of two fatty acids, stearocutic and oleocutic. All investigators agree that phellonic acid is lacking in cutin. On the other hand, van Wisselingh, in his summary of his researches on cutin and suberin, definitely states that there are no acids in suberin identical with the steareocutic and oleocutic of cutin. When both substances were heated in glycerin at 300°C. the residue from suberin is readily soluble in chromic acid while that from cutin is not. According to this author, both kinds of lamella yield ceric acid when oxidized with nitric acid and potassium chlorate. Cerine has never been mentioned as a constituent of cutin.

Since there appears to be a general agreement especially among the latter investigators that suberin and cutin are distinctly different substances, the question arises as to whether the ceric acid obtained in each case is the same compound, or varies according to its source.

Experimental.

When the cerine, which, according to Doepping (1) could be extracted from cork by hot alcohol or ether, was oxidized with nitric acid and potassium chlorate, the product obtained softened, but did not melt at the boiling temperature of water, whereas the product of oxidation of the cork residue, after the cerine was removed, or of the entire cork lamella, including the cerine, melted between 30° and 40°C. Evidently, similar observations led von Höhnel (4) to disregard cerine as the source of ceric acid. Since suberin and cutin are recognized to be aggregates of fatty acids, it seemed reasonable to assume that their products of oxidation may likewise be mixtures of the same fatty acids of which they are composed. The ceric acid obtained from the suberin of cork was investigated from this point of view.

The work of Gilson (3) was repeated, using a granulated cork, in order to gain familiarity with the details of analysis and also for the purpose of securing samples of the various acids for later comparison. The same method of analysis was

adapted as far as possible in the analysis of ceric acid produced from the ceric acid reaction.

The ceric acid was prepared by macerating granulated cork in a mixture of equal parts of a concentrated, aqueous solution of potassium chlorate and nitric acid specific gravity 1.42. The mixture was heated to boiling and the reaction allowed to continue until the cork was completely disintegrated and oxidation was complete. At this stage a layer of golden yellow wax-like substance fused together and spread over the surface of the liquid. After cooling upon ice it solidified and became brittle. The wax was then removed and washed with distilled water until no trace of nitrates remained; about 20 grams being prepared in this way. It was then dissolved in 250 cc. of boiling alcohol and filtered. Only the portion which was completely soluble in boiling alcohol was used in the analysis.

After filtering sufficient solid potassium, hydroxide was added to make a 3 percent solution and the acid was saponified by refluxing for one hour, care being taken to keep the solution distinctly alkaline to litmus paper. With the addition of the alkali, the color quickly changed, even with slight heating, from a straw yellow to dark brown. After refluxing and cooling upon ice a flocculent brownish white precipitate settled to the bottom of the flask. The precipitate was removed by filtering, washed with alcohol and recrystalized three times out of hot alcohol, by cooling. The alcohol was then removed by heating on a water bath. When some of the residue was then treated with a solution of iodine and potassium iodide and afterwards a few drops of 12 percent sulphuric acid or with chloro-zinc-iodide the typical rose or rose violet color indicative of potassium phellonate appeared.

The precipitate was further purified by boiling in a 25 percent solution of sodium chloride made alkaline with potassium hydroxide until the greater portion of the coloring matter was removed. It was then taken up in hot, distilled water and sulphuric acid added in excess to set free the acid from the potassium salt. After filtering, and washing to remove sulphates the residue was dried on a water bath; then recrystallized several times from alcohol, finally from chloroform, and allowed to stand in a desiccator over sulphuric acid for several days. The melting point was found to vary from 93° to 95°C. This is below the melting point of phellonic acid which is given as 95° to 96°C. When the residue was treated with chloro-zinc-

iodide particles were noticed which were yellow to yellowish brown in color, whereas the greater part of the preparation showed the rose or rose violet characteristic of phellonic acid and its salts, with the exception of the copper salt which colors brown. It was thought probable that this impurity was due to the fatty acid derived from the oxidation of the cerine. This acid appeared to be similar in solubility reactions to the phellonic and its potassium salt. It was very difficult to remove this impurity. After crystallizing again three times from hot alcohol, and the same number of times from boiling chloroform, a product was obtained which melted at 95°C. When a portion of this acid was thoroughly mixed with an equal quantity of known phellonic acid which had previously been extracted from cork, the melting point remained unchanged. The evidence appeared to be sufficient to conclude that phellonic acid had been isolated from the product of the ceric acid reaction.

The potassium salt of phellonic acid prepared from the acid gives the distinguishing rose or rose violet color with the iodine reagents, much better than the crude salt. This salt also gives the color reaction much more readily than the acid. When small particles showing the rose violet color were removed from the iodine solution and placed in a drop of water, the color promptly disappeared. It also disappeared from the iodine solution upon warming, and reappeared upon cooling.

The analysis was continued with the first filtrate following Gilson's (3) method and both suberic and phloïonic acids were isolated. These acids forming the product of the ceric acid reaction, appeared to be identical with those obtained from cork by the extraction method. Only a very small quantity of phloïonic acid was secured, not enough for confirmatory melting point determinations. The fine needles which crystallized out of hot water, upon cooling, could not be distinguished from those isolated from the cork extract. Less attention, however, has been directed to these acids because no tests have been discovered for their detection which would be adapted for microchemical use. It is for this reason that so much attention has been given to phellonic acid, more particularly to its potassium salt. The color which is given with the iodine reagents is so distinctive that it can be detected in very minute quantities; yet there is less than one fourth as much phellonic acid as suberic acid in the suberine of cork, according to Gilson (3).

Summary and Conclusion.

The results of former investigations (Gilson (3), van Wisselingh (7), Priestley (6), regarding the nature of suberin would indicate that it is an aggregate made up of a number of fatty acids in varying degrees of plolymerization. It may also be infered that these acids are in some form in which they are insoluble in the common organic solvents. It is evident that they do not occur as acids or as salts, because none of them are present in the alcoholic extract of cork. When suberized lamellæ are treated with a strong oxidizing reagent such as nitric acid and potassium cholrate these acids fuse together forming a substance commonly referred to as "ceric acid," or cork wax. In the state into which they fuse they manifest a common property toward the action of such organic solvent as hot chloroform, alcohol, ether and benzol, but are insoluble in water.

It could undoubtedly be possible to detect and isolate other fatty acids in the oxidation product of suberin. No attention has been given to the identity of the acid which would be derived from cerine. It has been my particular interest to determine if the three fatty acids reported by Gilson (3) to be present in suberine still maintained their identities in the oxidation product of this substance. This has been done. The term "ceric acid reaction" is evidently misleading and should more properly be designated as the "oxidation reaction," because only a very small part of the fatty acids incorporated in the oxidation product of suberin, comes from the cerine.

There is considerable reason to believe that the composition of suberine may vary in different plants depending upon the conditions under which it is formed. Gilson was not able to isolate any phloïonic acid from elm bark. If this proposition be true, it must follow that the oxidation products must also show wide variation when applied to different types of suberized lamella.

Even with our present conception of the constitution of cutin, there is no reason to believe that the oxidation product of this substance has very much in common with that of suberine. Fremy and Urbain (2) have reported two fatty acids present in cutin of Agave, viz. oleocutic and steareocutic. While the first may resemble in some respects the suberic acid of suberin, the steareocutic appears to be entirely different

from any of the suberogenic acids yet known. The oxidation reaction with respect to cutin requires further investigation.

Possibly, this interpretation of the ceric acid reaction may aid in further investigations of suberized lamellæ, particularly in tissue where the amount of suberin may be relatively small. In such cases there is difficulty at times in differentiating the action of the iodine reagents upon cellulose and suberized lamellæ after macerating in concentrated potassium hydrate. Von Höhnel erred in this connection and von Wisselingh (8) pointed out his mistake. By saponifying the fusion products of oxidation with a 3 to 5 percent solution of alcoholic potash, and cooling, the potassium phellonic salt will precipitate out, if suberin is present. Separate the precipitate from the liquid by filtering and wash several times with 95 percent alcohol. To a small portion of the residue on a glass slide or watch glass add a few drops of chloro-zinc-iodide. If the potassium salt of phellonic acid is present it may readily be detected by the characteristic rose or rose violet color of the disc-like crystals, which commonly form in clumps or aggregates.

LITERATURE CITED.

1. Doepping, von O.
Chemische Untersuchung der Rinde der Korkeiche. (Quercus suber L.). Annalen der Chemie und Pharmacie. Vol. 45, p. 286–298. 1843.

2. Fremy, E. et Urbain.
Etudes chemique sur le squelette des vegetaux. (III Partie, la cutose). Compt. Rend. T. C. No. 1, p. 24, January, 1885.

3. Gilson, E.
La Suberine et les cellules du Liege. La Cellule, Vol. 6, p. 67–108. 1890.

4. Hoehnel, Franz V.
Uber der Kork and verkorkte Gewebe uberhaupt O. Sitzung. Akad. der Wissen, Vol. 76, p. 507. 1877.

5. Kuegler, K.
Uber das Suberin. Dissertation, Strasburg. 1884.

6. Priestley, J. H.
Suberin and Cutin. New Phytol. Vol. 20, p. 17. 1921.

7. Wisselingh, C. van.
Sur la Cuticularization et le Cutine. Neerland des Sciences, Exact et Naturelle. Vol. 28, p. 26. 1894.

8. ———.
Sur la paroi des cellules subereuses. Arch. Neerland des Sciences exact et naturelle. T. XXII, p. 253–298. 1888.

THE DEVONIAN SECTION ON PINAL CREEK, ARIZONA.[1]

CLINTON R. STAUFFER,
Department of Geology, University of Minnesota

Introduction.

Pinal Creek originates in the Pinal Mountains of south central Arizona and flows northward through Globe to Salt River, just above the Roosevelt Reservoir. This latter is some twenty miles distant from the mining camps. Solitude Gulch, Bloody Tanks Wash, Lost Gulch, and others of similar character, unite to form an important tributary to Pinal Creek flowing through Miami. A short distance to the east of Globe the drainage flows east and south to the Gila River. Pinal Creek is thus the master stream of the Globe-Miami region. Its ramifying branches cut many fine sections in their steeper portions and the sparseness of vegetation makes these unusually available for study.

Globe is a thriving modern town partially independent of its mining connections. Most of the mines are located to the north and northeast on Buffalo Ridge and in Copper Gulch. A similar mining area lies to the west and northwest of Miami—a much more typical Arizona mining town a few miles to the west of Globe. The mineralized areas of the region are highly faulted and thus constitute a mosaic of formations[2] in which blocks of Devonian limestone take an important part. These are matched up against other Paleozoics, pre-Cambrian metamorphics, intrusives, and volcanics of various ages. The abundance of these faults makes it difficult to piece out the section, especially since portions of it are apparently unfossiliferous. It is probable, therefore, that systems, other than those now included in the general section, may be represented among the remnants.[3]

---

[1]Presented by title before the Ohio Academy of Science, April 6th, 1928.

[2]Ransome, F. L., U. S. G. S. Folio No. 111, 1904, Areal Geol. Map.

[3]Ransome, F. R., The Geology of the Globe District, Arizona. Mining and Scientific Press, Vol. 102, 1911, pp. 747–748.

Location of Section.

The section here discussed is that from which Dr. Ransome collected most of the original Globe Devonian fauna,[4] and one which was found especially fossiliferous during the field work on which the present paper is based. Unfortunately it lacks the exceedingly important fossil, *Pugnax pugnus* which Dr. Ransome found in the Devonian beds of the southeast corner of the Globe quadrangle, and which has been found at various other localities in Arizona.

The Pinal Creek Section is located at an east facing limestone bluff just off the Apache Trail 3¾ miles north-northwest of Globe, and about ¾ of a mile northeast of McLean's ranch. The limestone is faulted and dips as great as 55 degrees S. S. E. were measured. The Devonian is typical Martin limestone[5] lithologically similar to that found on the slopes of Mt. Martin or above the Phelps-Dodge concentrator southeast of Bisbee. This identity is definitely proven by the fauna although at Globe the Martin limestone carries a somewhat different grouping of forms than is characteristic of it in the Bisbee region.

The Pinal Creek Section.

The following section occurs at the Limestone Bluff on the west side of Pinal Creek, 3¾ miles northwest of Globe, Arizona.

Mississippian.

Lower Tornado Limestone.

		Thickness
31.	Limestone, highly crystalline, gray, weathering light gray; some chert. These beds contain crinoid stems together with Mississippian corals and brachiopods	100′ 0″
30.	Limestone hard, dark gray to bluish; it contains some rather poorly preserved corals and the upper part is commonly crinoidal	50′ 0″
29.	Shale, brown to buff, at places reddish and massive. Apparently unfossiliferous	30′ 0″

[4]Williams, H. S., U. S. G. S. Prof. Paper No. 12, 1903, pp. 40–42, and Ransome, F. L., idem., pp. 44, 45; also U. S. G. S. Folio No. 217, 1923, p. 8, and U. S. G. S. Prof. Paper No. 115, 1919, p. 46.

[5]Ransome, F. L., U. S. G. S. Folio No. 112, 1904, pp. 3–4, and Prof. Paper No. 115, 1919, pp. 45–47.

DEVONIAN.

Martin Limestone. Thickness

28. Limestone, hard, bluish weathering buff. Fossils abundant.
Crinoid fragments
Nortonechinus primus F. & F.
Atrypa reticularis (Linnaeus).
Productella hallana Walcott.
Spirifer hungerfordi Hall.
Spirifer whitneyi Hall..... 7′ 8″

27. Limestone, fairly massive, hard, gray to bluish gray, crinoidal.
Crinoid stems
Atrypa hystrix Hall.
Atrypa reticularis (Linnaeus).
Atrypa spinosa Hall.
Spirifer hungerfordi Hall..... 6′ 0″

26. Limestone, massive, gray, abundantly fossiliferous.
The Atrypa bed
Atrypa hystrix Hall.
Atrypa reticularis (Linnaeus).
Atrypa spinosa Hall.
Spirifer hungerfordi Hall.
Spirifer whitneyi Hall..... 2′ 0″

25. Limestone, shaly, gray; somewhat arenaceous and with several chert bands, one of which is at the base..... 5′ 0″

24. Limestone, shaly, gray to buff, argillaceous..... 8′ 4″

23. Limestone, with shaly partings, gray arenaceous. Crinoid segments and a few other fossils occur sparingly.
Crinoid stems
Atrypa hystrix (?) Hall.
Atrypa spinosa Hall.
Atrypa sublepida Verneuil.
Stropheodonta sp.
Spirifer sp..... 5′ 6″

22. Shale, gray and nodular gray limestone which is often shaly. Very fossiliferous.
Alveolites rockfordensis (H. & W.).
Aulopora cf. iowaensis (H. & W.).
Aulopora paucitubulata (?) F. & F.
Cladopora labiosa (?) Billings.
Cladopora sp.
Cyathophyllum cf. minus Roemer.
Heliophyllum solidum (H. & W.).
Hederella alternata (H. & W.).
Macgeea solitaria (H. & W.).
Pachyphyllum cf. levatum W. & F.
Tabulophyllum sp.
Codaster sp.
Hexacrinus n. sp.

Thickness

Crinoid stems
Nortonechinus primus F. & F.
Fenestella diatreta F. & F.
Atrypa desquamata Sowerby.
Atrypa duboisi (?) Verneuil.
Atrypa hystris Hall.
Atrypa reticularis (Linnaeus).
Atrypa spinosa Hall.
Atrypa sublepida Verneuil.
Cranaella navicella Hall.
Cyrtia cyrtiniformis H. & C.
Cyrtina iowaensis F. & F.
Gypidula cornuta F. & F.
Leptostrophia canace H. & W.
Productella hallana Walcott.
Productella sp.
Schizophoria striatula (Schlotheim).
Schuchertella parva (Hall).
Spirifer orestes H. & W.
Spirifer subvariocosus H. & W.
Spirifer whitneyi Hall.
Spirifer whitneyi gradatus Fenton.
Spirifer sp.
Stropheodonta arcuata Hall.
Stropheodonta sp.
Strophonella reversa (Hall).
Bellerophon sp.
Diaphorostoma (?) sp.
Floydia concentrica (?) Webster.
Straparollus circinatus F. & F.
Tentaculites sp.
Autodetus slocomi F. & F. ..... 18′ 0″

21. Limestone massively bedded, blue to gray, arenaceous. Somewhat crinoidal and fairly fossiliferous.
Zaphrentis sp.
Crinoid stems
Atrypa reticularis (Linnaeus).
Spirifer sp. ..... 12′ 6″

20. Shale, gray to brown, weathering buff. Some thin limestone lenses occur in the shales ..... 12′ 0″

19. Limestone, massive, hard, arenaceous and brown in color .. 2′ 8″

18. Limestone, crinoidal, gray, arenaceous.
Crinoid stems
Atrypa hystrix Hall.
Atrypa spinosa Hall ..... 2′ 0″

17. Sandstone, calcareous, gray, cross-bedded ..... 3′ 0″

16. Shale, gray weathering to buff ..... 10′ 0″

15. Limestone, shaly, gray, somewhat crinoidal ..... 2′ 0″

		Thickness
14.	Limestone, an uneven layer of gray limestone filled with crinoid stems, many of which are large. *Crinoid stems and plates*	0′ 3″
13.	Limestone, fairly massive, gray, often nodular and occasionally shaly. This bed is somewhat crinoidal	6′ 0″
12.	Limestone, gray, filled with crinoid fragments. *Crinoid stems and fragments* *Atrypa duboisi* (?) Verneuil. *Atrypa reticularis* (Linnaeus). *Atrypa spinosa* Hall. *Cranaena iowaensis* (?) Calvin. *Leptostrophia canace* (H. & W.). *Schizophoria striatula* (Schlotheim). *Schuchertella coloradoensis* Kindle. *Schuchertella* sp. *Spirifer macbridei* Calvin. *Spirifer whitneyi* Hall	0′ 3″
11.	Limestone, thin bedded, nodular, gray arenaceous, with a few crinoid segments scattered through it. *Atrypa reticularis* (Linnaeus). *Leiorhynchus nevadaense* Walcott. *Pentamerella* sp. *Schuchertella parva* (Hall). *Stropheodonta* sp. *Spirifer whitneyi* Hall. *Strophonella hybrida* H. & W.	8′ 4″
10.	Sandstone, massive, medium to coarse, cross-bedded, hard, gray weathering brown	13′ 3″
9.	Limestone, shaly arenaceous, gray to brown	2′ 0″
8.	Limestone, laminated, often thin-bedded, drab to slate colored	1′ 10″
7.	Limestone, massive, compact, hard, gray, weathering buff	4′ 8″
6.	Limestone, massive, compact, hard, arenaceous, gray weathering to buff	14′ 6″
5.	Limestone, massive, compact, hard, brown to pink and gray weathering to buff	14′ 0″
4.	Shale, argillaceous, gray to purple	3′ 0″
3.	Limestone conglomerate, hard drab pebbles in a brown matrix, all compact and hard. Some chert	4′ 0″
2.	Limestone, massive, compact, hard drab, weathering light gray	35′ 0″
1.	Covered interval to Pinal Creek, at right angles to dip	12′ 0″

No fossils were found in numbers 1 to 10 of the above section and these may not belong to the Devonian. About 200 yards down the stream the Pinal schists are exposed and overlying them with angular unconformity are conglomerates and sandstones but these have not been included in the measurements here given.

Faunal Discussion.

The Martin limestone fauna, occurring abundantly in bed 22 and sparingly in several of the others in the above section, is characterized by fewer corals and more brachiopods than commonly occur in this formation at Bisbee where several horizons might be described as veritable coral reefs. It is, however, the characteristic Martin fauna in every respect and as such is widely distributed over Arizona. Faulting has cut out so many beds at different localities that the complete section and fauna of the Martin will only be known when the whole south-western Devonian has been systematically covered in one complete and exhaustive study.

The fauna is the same as the typical Iowa upper Devonian and many of the Arizona forms can be matched by species from the Hackberry (Lime Creek) shales at Hackberry Grove, Iowa. Dr. Walcott[6] identified with Iowa forms a number of the species from the Great Basin but the identity of the Arizona fauna with the upper Devonian of Iowa was first pointed out by H. S. Williams[7] and this has been confirmed by others who have had an opportunity to examine such collections as have been made in both places. This relationship is becoming more apparent with every new collection and many of the species mentioned in the section above, when compared with specimens from Hackberry Grove, are indistinguishable. This does not appear to be true of any other fauna with which the Hackberry has been compared. As observed by C. L. and M. A. Fenton,[8] there is a certain faunal relationship existing between the Hackberry and the upper Devonian of other parts of North America. This was long ago recognized by C. S. Prosser and others, and has been the basis on which the supposed identity of some closely related forms has been established. It has likewise influenced the distribution of land and sea on the paleographic maps of the time.

In Dr. Walcott's Devonian collection from the Eureka and White Pine Districts of Nevada,[9] more than half of the species are from the lower part of a 6000 foot limestone. More than half of the remainder, or 61 species, are from the upper part of the same limestone. Many of these latter, and about

[6]U. S. G. S. Mono. VIII, 1884, pp. 274–278.
[7]U. S. G. S. Prof. Paper XII, 1903, p. 42.
[8]The Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian, 1924, p. 17.
[9]U. S. G. S. Monograph VIII, 1884, p. 4–8, 274–278. Also Monograph XX, 1892, pp. 325–330.

a third of those from the overlying 2000 feet of shales (White Pine), indicate the presence of the Martin fauna. Dr. Walcott himself says that "there is little doubt but that future collections from the area of the Great Basin will give a very complete series of species, and still further increase the number of species common to the eastern and central (or Atlantic and Mississippi) areas and the western or Rocky Mountain area."[10] There is thus forecast the possibility of additional and larger collections to be made from the higher Devonian beds of Nevada and the ultimate segregation of the Martin fauna, the presence of which is certainly suggested by the list of species already known from that region. The success of such an undertaking has become more probable since J. S. Diller[11] found part of the Martin fauna in northern California and its wider distribution becomes evident.

Although many Hackberry species resemble those from other regions, notably the East and the North, "close examination shows that, with few exceptions, they present apparent and constant differences."[12] It is probable that this is more applicable to the brachiopods but it may eventually be found to be equally true of many of the other fossil forms found throughout the southwestern Devonian province. If this is a fact, as it appear to be, the Arizona forms identified as *Schizophoria striatula* Schlotheim should be returned to *S. iowaensis* (Hall) and the western *Pugnax pugnus* (Martin) should be either *Pugnoides calvini* F. & F. or *Pugnoides solon* (T. & S.) as Fenton and Fenton[13] have done with the Hackberry forms in Iowa. The Martin fauna, when completely known, will probably exceed the Hackberry in richness of species, but the Iowa fauna is now much better known and mostly in a state of perfect preservation. This latter is only partially true of the Martin fauna. The Hackberrry of Iowa should therefore be used as the standard of comparison for this southwestern or Martin fauna and for all others supposed to contain identical species. A related fauna, probably a later recurrent phase of it, occurs in the Ouray limestone of Colorado[14] and abundantly in the Percha shale of the southwestern part of New Mexico.[15]

---

[10]U. S. G. S. Monograph VIII, 1884, pp. 7, 8.
[11]Am. Jour. Sci., 4th Ser., Vol. XV, 1903, p. 348.
[12]Fenton, C. L., and Fenton, M. A., Op. cit., p. 17.
[13]Op. cit., pp. 83–85, 125–129.
[14]Kindle, E. M., U. S. G. S. Bull. 391, 1909, pp. 1–14.
[15]Gordon, C. H., and Graton, C. L., Am. Jour. Sci., 4th Series, Vol. XXI, 1906, pp. 394–395. Idem Abs. Jour. Geol., Vol. XV, 1907, pp. 91–92. Also Lindgren, W., Graton, L. C., and Gordon, C. H., U. S. G. S. Prof. Paper 68, 1910, p. 228.

The territory intervening between the region in which the Martin occurs and the Iowa-Missouri Devonian region is unmarked by outcrops of this age. A large part of that territory, however, has been so frequently depressed and covered by marine invasions, bringing in the later sediments, that any existing Devonian remnants are deeply buried beneath Mississippian or later formations. Although it is probable that species occur in Arizona which may not be found in Iowa, and vice versa, still the relationship between the Martin fauna and that of the Hackberry of Iowa is too intimate to admit of any other interpretation than a direct communication between the two. Some of the Martin-Hackberry species, or closely related forms, reached the eastern part of the North American continent by late Devonian time, but the fauna as a whole did not get farther in that direction than Iowa, its most characteristic species being entirely lacking in the New York upper Devonian. The probability is, therefore, that the migratory route to the East, for such species, or their varieties, as reached northern Michigan and New York, was not by way of Iowa but by some more roundabout way, such as the Mackenzie valley, where these same southwestern species that are absent in New York also appear to be wanting.

It has been pointed out, especially by Professor Schuchert,[16] that the southwestern upper Devonian is an Eur-Asiatic fauna. However, it should also be noted that when the epicontinental sea, in which this fauna was prevalent, extended uninterruptedly from the Pacific across northern Mexico, California, Nevada, and Arizona northeastward to Iowa and Missouri, it was one of the great Devonian embayments of the continent and dwarfed to comparative insignificance the eastern Devonian invasion with the fauna that is usually regarded as more or less typically American. The Martin-Hackberry fauna is therefore as much at home on this continent as it is in Europe and only a little less so here than in Asia. It would probably more nearly express the truth to consider the whole region from the central and western part of North America, across Asia to Europe as one great Devonian province and add the name of this continent to that used by Schuchert, making it the Eurasio-American province.

[16]Am. Jour. Sci., 4th Ser., Vol. XV, 1903, p. 348.

THE STRUCTURE OF THE DIGESTIVE SYSTEM IN CREOPHILUS VILLOSIS

MARY TALBOT,
University of Omaha.

Introduction.

The beetles used in this study were procured at the Columbus, Ohio, Packing House, where they lived in and around an open shed, "the hair house," where fly larvæ were abundant in masses of hair. Here they were found in large numbers in early fall. Occasionally one or two were obtained from fly larvæ infested meat placed out of doors at the Ohio State University. This large black staphylinid with silvery white markings is usually known as *Creophilus villosis* (Grav.) but is listed by Long as variety *villosis* of the species *Creophilus maxillosis* (L.).

I wish to express my appreciation to Doctor C. H. Kennedy under whose supervision the work has been carried on.

The Gross Anatomy of the Alimentary Canal of the Adult.

The alimentary tract is relatively short in correlation with the carniverous habits of the beetle. It extends as an almost straight tube only slightly longer than the body itself. (Fig. 1).

The *fore-intestine* begins with a small pharynx limited to the anterior part of the head. This narrows quickly into a slender oesophagus extending into the prothorax where it gradually widens into the gizzard. In the mesothorax the gizzard is constricted at the beginning of the mid-intestine or stomach.

The *mid-intestine* is large in diameter and comprises about one-half the length of the entire tract. At the posterior end it loops back upon itself for a short distance. The stomach is covered from beginning to end with large and conspicuous pipillaform crypts which give a dense white appearance.

The *hind-intestine* is transparent enough so that often the chalky white contents can be seen being moved about by peristaltic action. This action often continues for a number of

minutes after the beetle is chloroformed and placed in normal salt solution. Four Malpighian tubules arise at the beginning of the hind-intestine. They are long and coil about the alimentary tract and fat bodies. The hind-intestine has only two visible regions. The most anterior of these (ileum) is slender and short and is usually looped or folded upon itself. The posterior part (colon) loops once then extends caudad. The rectum is not differentiated to outward appearance from the colon.

Terms such as ileum, colon, and rectum are used rather arbitrarily because these parts vary too much in form, structure, and proportion in various species of beetles to be exactly homologyzed.

The Histological Structure.

Pharynx.—The mouth opens into a short, thickly chitenized, muscular pharynx (Fig. 5). The intima is thick, almost transparent, and has a rough surface from which short hair-like processes of chiten extend in imbricated rows, (Fig. 3). These hairs are found on about one-half the inner surface being lacking on the ventral side. The cuboid epithelial cells secreting the intima are very small. The muscles do not form a definite inner longitudinal layer and an outer circular layer, but show a confusion of pharyngial muscles and attachment muscles. The latter extend diagonally out to the chiten of the head and serve to expand the pharynx.

Oesophagus.—The intima of the oesophagus is much thinner than that of the pharynx and is thrown into a number of irregular, shallow folds, (Fig. 6). There are no hairs throughout the length of the oesophagus. The epithelium consists of a layer of small cells. Longitudinal muscles are sparsely distributed. Near the base of the pharynx they form a complete covering of the epithelial cells but further back they become scattered and a cross section may show from one to four. Circular muscles form a complete outer layer two or three muscles thick.

Gizzard.—As the oesophagus gradually widens into the gizzard the intima again thickens and hairs appear which are larger and longer than those in the pharynx. These are arranged in rows on and between slight ridges of chiten which encircle the pharynx giving its inner surface a ringed appearance, (Fig. 4). The hairs extend into eight groups which meet in

the center and twirl about, (Fig. 2). They point slightly caudad, probably being pushed back by in-coming food. The epithelium cells are small and often indistinct. Connective tissue joins the epithelium cells with the longitudinal muscles which fill in the eight folds, (Fig. 7). These are of two distinct sizes, the larger muscles being on the outside of each fold, and the smaller muscles filling up the inner part. Two or three layers of large circular muscles surround the whole.

Oesophageal Valve.—The end of the fore-intestine is marked by the oesophageal valve, (Fig. 9). Here the eight folds lose their characteristic shape, become more rounded, and are reduced to from five to seven. The intima changes to a smooth, hairless, slightly thickened covering of the valve which ceases rather suddenly at its posterior end. Epithelial cells become large and elongate. The muscles do not retain their distinct layers but intertwine as they form their attachments to the valve.

Mid-Intestine.—In Creophilus the mid-intestine is distinct in a number of ways.

The epithelial cells reach out through the muscular wall of the stomach as a loose pyle of long crypts measuring as much as eighty mu in length, (Fig. 10). At the outer end of each crypt is a nidus of cells consisting almost wholly of large nuclei. The cells that originate in the nidi make their way down the crypts and become the large secreting cells. At the extremity each crypt is solid but nearer the inner surface of the stomach the cells do not reach entirely to the center in some places and so form irregular spaces in the middle. Korschelt (*Bearbeitung Einheimischer Tiere. I Monographie. Der Gelbrand Dytiscus Marginalisl*) speaks of these spaces as vacuoles and states that they contain digestive fluids. The epithelial cells not only extend out from the muscle wall but also develop folds into the lumen of the stomach. Secretion is holocrine so that at the inner ends of the crypts cells are constantly being broken down to liberate digestive enzymes, and as they are sloughed off new cells take their place. As is usual with secreting cells the cytoplasm as well as the nucleus stains a deep blue in Delafield's Hemotxylin.

The muscular layer cannot be said to surround the epithelial cells but is sunk in among the crypts forming a perforated structure through whose openings the crypts extend. Back of the oesophageal valve the layers have changed position, the

circular muscles being on the inside and the longitudinal muscles covering them externally. The longitudinal muscles branch occasionally and do not run very regularly because of interference of the crypts. The circular layer is thicker and is matted together with minute branched strands running all through it but which are more concentrated on its inner surface. These small strands show no striations and sometimes seem to extend from the circular muscles and sometimes from cells lying loosely in the layer, (Fig. 11, con.). The first interpretation of this mat of branching hair like fibers was that they were minute branched muscle fibres or perhaps connective tissue cells. Later Mr. Warren Miller found a similar layer in the stomach wall of a Meloid beetle, Meracantha, where they were demonstrated to be tracheoles. This is probably the correct interpretation of this layer in Creophilus. Each crypt has a layer of these strands covering it. Larger fibres (but considerably smaller than the ordinary striated muscle) extend lengthwise, twelve or more running out each crypt. The space between these is filled by very fine strands which encircle the crypt, (Fig. 8). The two together form a complete though thin covering.

Malpighian Tubules.—The beginning of the hind-intestine is marked by the Malpighian tubules, (Fig. 14). They are four in number arising close together at the posterior end of the stomach at almost the same level from which the last crypts extend. They are composed of huge cells, large nucleated and of indistinct cell walls, surrounding a lumen and bounded on the outside by a thin membrane of connective tissue.

Pyloric Valve.—This valve is composed of a ring of elongate epithelial cells thrown into a number of folds, (Fig. 12). They are covered by a thin intima which begins at the anterior end of the valve and lines the entire hind gut. Here again the muscles intertwine so that there is no distinct inner or outer layer. Muscles branch as they run obliquely to the epithelial cells pulling them out to allow the opening of the valve.

Ileum.—In the iluem the intima is also thin and closely applied to the epithelial cells which are fairly small and regular. The epithelium is thrown into many irregular folds, (Fig. 13).

Muscles form a very thick layer about the ileum. There is no definite longitudinal layer but the muscles run more or less obliquely in every direction. Near the anterior end there are many muscles which branch to form narrow attachments to

the epithelial cells, and by contracting serve to pull out the folds, thus enlarging the ileum, (Fig. 12).

Colon.—The ileum is very short and suddenly widens into the colon, (Fig. 15). The intima continues as a very thin layer and the epithelial cells become much larger. The folds become more regular. At first there are from five to seven folds but further back these increase to from twelve to fifteen, (Fig. 17). About half way down the colon the folds become less distinct and widen out to form six or seven shallow corregations, (Fig. 16).

Usually in insects the hind-intestine has three layers of muscle, an inner circular layer, a middle longitudinal layer, and an outer circular layer. In Creophilus the longitudinal muscles seem to be lacking so the circular muscles are not differentiated into two layers. Throughout the muscle layer of the colon there are many tracheoles as described in the walls of the stomach, the circular muscles being bound together by them. The layer is also held closely together by branching of the muscles so that they twine about each other.

In the alimentary tract branching of the muscles appears to perform three different functions. In the stomach branching serves to circumvent the crypts. In the pyloric valve and ileum branches multiply the number of attachments to the epithelial cells. While in the colon branching binds the muscles closer together.

Rectum.—Near the anus the intestine narrows to form the rectum, (Fig. 18). The intima is very much thickened and roughened at the surface. There are six or seven epithelial folds which are drawn close together. The circular layer of muscles is thicker here than in the colon.

EXPLANATION OF PLATES.

Plate I.

Fig. 1. Entire alimentary tract.
Fig. 2. Cross-section through gizzard.
Fig. 3. Portion of chiten of gizzard showing arrangement of hairs.
Fig. 4. Portion of chiten of pharynx showing arrangement of hairs.
Fig. 5. Longitudinal section through pharynx.
Fig. 6. Cross-section through oesophagus.
Fig. 7. Portion of Fig. 2.
Fig. 8. Cross-section through crypt near base showing covering of connective tissue.
Fig. 9. Longitudinal section through oesophageal valve.
Fig. 10. Longitudinal section through stomach showing one crypt.
Fig. 11. Cross-section through crypts near base, showing muscle and connective tissue.

Plate II.

Fig. 12. Longitudinal section through pyloric valve.
Fig. 13. Cross-section through ileum.
Fig. 14. Cross-section through pyloric valve, showing Malpighian tubules.
Fig. 15. Longitudinal section through ileum and colon.
Fig. 16. Cross-section through anterior part of colon.
Fig. 17. Cross-section through posterior part of colon.
Fig. 18. Cross-section through rectum.

Key to Abbreviations.

c. Mus.....Circular Muscle.
Con.....Tracheoles.
E.....Epithelium.
Giz.....Gizzard.
Int.....Intima.
L. Mus.....Longitudinal Muscle.
Malp.....Malpighian tubule.
Mus.....Muscle.
Oes.....Oesophagus.
Ph.....Pharynx.
St.....Stomach.
Rect.....Rectum.

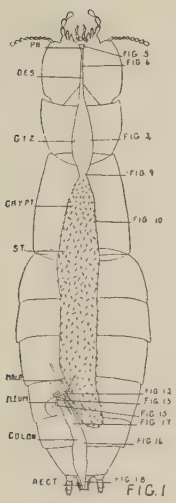
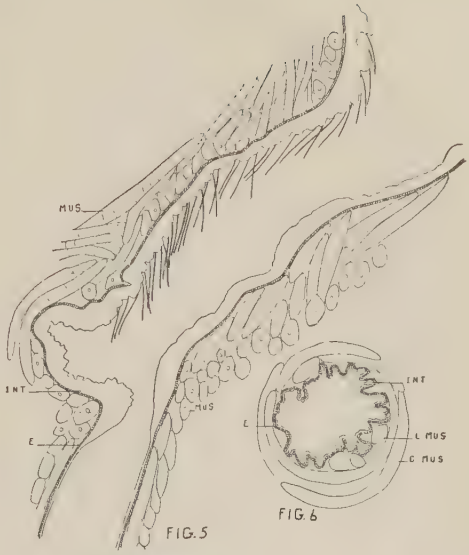
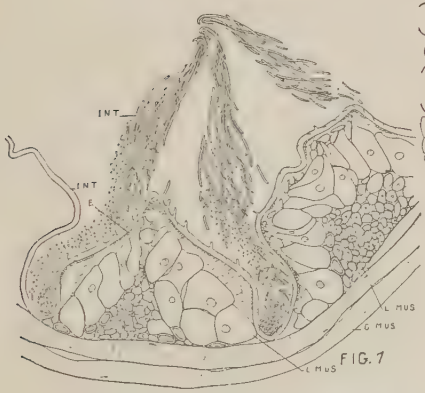

PH
OES
GIZ
CRYPT
ST
MALP
ILEUM
COLON
RECT
FIG. 1

FIG. 2

FIG. 3

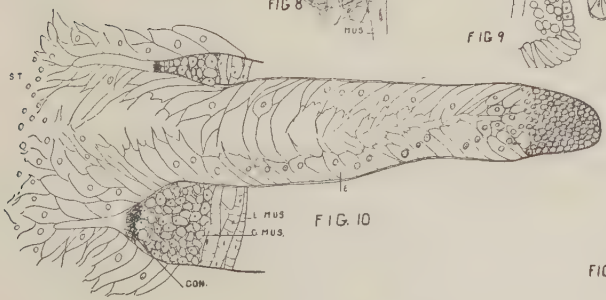
FIG. 4

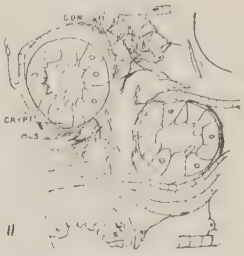

MUS
INT
E
MUS
INT
L
L MUS
C MUS
FIG. 5
FIG. 6


INT
INT
E
L MUS
C MUS
L MUS
FIG. 7

GIZ
C MUS
INT
L MUS
L
ST
FIG. 9

CON
MUS
FIG. 8


ST
L
L MUS
C MUS
CON
FIG. 10


CON
CRYPT
MUS
FIG 11

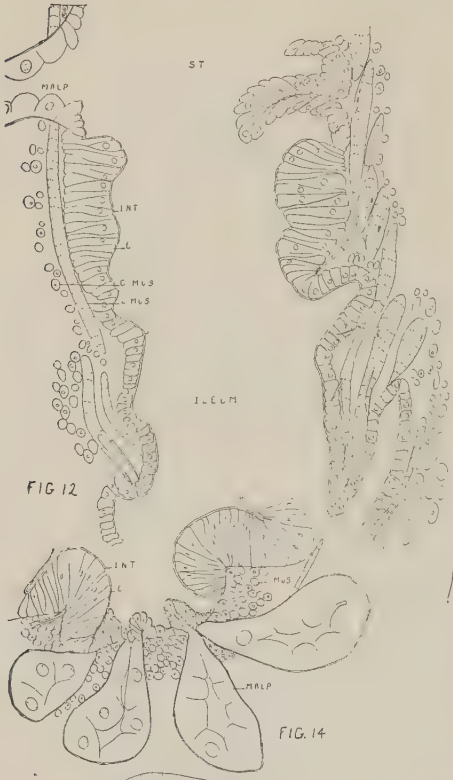


FIG. 12

FIG. 14

FIG. 13

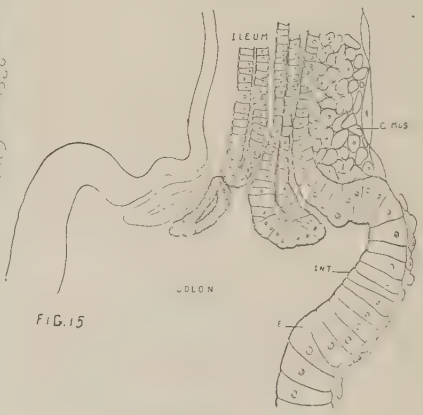


FIG. 15

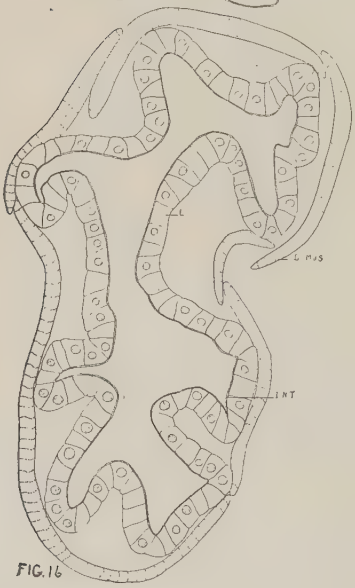


FIG. 16

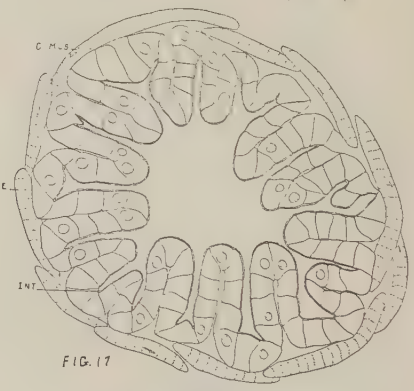


FIG. 17

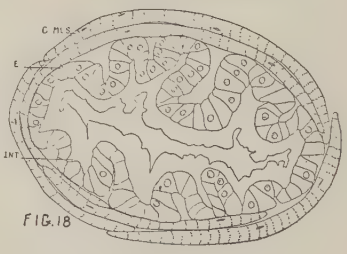


FIG. 18

CONCERNING SOME NORTH AMERICAN WATER-STRIDERS WITH DESCRIPTIONS OF THREE NEW SPECIES

C. J. DRAKE AND HALBERT M. HARRIS,
Ames, Iowa.

Recent publications on North American water-striders have resulted in a need for revised distributional data. This is especially true for certain species of the family Gerridæ. To illustrate, eight or nine different species have been placed under the name of *Gerris marginatus* Say in the literature. The following notes are based on the water-striders in the collections of Iowa State College, the University of Minnesota, the University of Illinois, the Montana State College, Professor H. E. Summers, Mr. Wm. J. Gerhardt, and the authors.

Gerris remigis Say. (Fig. 1, a).

Say, Thomas, Heter. N. Harm., p. 35, 1832.
Stal, C., Frey, Eugen. Resa. Ins. p. 264, 1859 (*Gerris orba*).
Uhler, P. R., Am. Jl. Sci., ser 3, I, p. 105, 1871 (*Hygrotrechus robusta*).

This is the most common and widespread gerrid in North America. It frequents the wider portions of small streams but is not uncommon in creeks, rivers, ponds and lakes. Both winged and wingless forms occur throughout its entire range. The color and size, even in specimens taken from the same colony, show marked variations. The spines at the ends of the connexiva vary in length. A cotype of *Gerris orba* Stal kindly sent to us by Dr. Yngve Sjostedt, Intendent of the Naturhistoriska Riksmuseet at Stockholm, is before us; it is a typical *G. remigis*. This specimen and the type series at Stockholm bear labels "= *remigis* Say, teste Kirkaldy." The male genitalia of the cotype of *G. orba* Stal (snyn. of *G. remigis* Say) is figured.

A long series of specimens taken at the type locality of *Gerris robusta* Uhler by Mr. E. P. Van Duzee of the California Academy of Science are also typical examples of *G. remigis*. Furthermore, specimens determined by Uhler himself as *G. robusta* are identical with *G. remigis*. The type of *G. robusta* (a damaged female, according to the original description) cannot be found in Uhler's collection, the National Museum, or the Museum of the California Academy of Science. After having studied several hundred specimens of *G. remigis*, some of which have come from every state in the union (with the exception of one or two), Canada and Mexico, the writers feel that both *G. orba* Stal and *G. robusta* Uhler must stand as synonyms of *Gerris remigis* Say.

Gerris nyctalis Drake and Hottes. (Fig 1, b).

Specimens are at hand from the following localities: COLORADO—Dolores, Estes Park, Garrison, Ft. Garland, Pagosa Springs, Placerville, North Park, South Fork, and Veta Pass, August, 1925, C. J. Drake. WASHINGTON—Lake Sutherland, August 8, 1927, C. R. Crosby. CALIFORNIA—Fresno, June 20, 1926, C. J. Drake. IDAHO—Caldwell, July 9, 1926, C. J. Drake. MONTANA—Bozeman, R. A. Cooley.

Gerris nebularis Drake and Hottes. (Fig. 1, c).

In addition to the type localities specimens are at hand from the following states: SOUTH CAROLINA—Clemson, July 9, 1914, F. H. Lathrop. ALABAMA—Birmingham, March 21, 1925, R. Cecil. TENNESSEE—Knoxville, June, 1890, H. E. Summers. MISSISSIPPI—Charleston, Sept. 7, 1925, H. M. Harris; A. and M. College, June 24, 1914, R. W. Harned. NEW YORK—Syracuse, July 26, 1921, C. J. Drake. IOWA—Mt. Pleasant, July 14, 1927, Harris and Johnston. Kansas—Ottawa, May 20, 1925, B. M. Harrison.

Gerris insperatus Drake and Hootes.

OHIO—Wellington, August 7, 1890, H. E. Summers. ILLINOIS—Homer, April 27, 1907. NEW YORK—Cranberry Lake, July 22, 1919, C. J. Drake; Ithaca, May 4, 1888, H. E. Summers. ALABAMA—Birmingham, March 21, 1925, R. Cecil. TENNESSEE—Knoxville, March 17, 1889, H. E. Summers. SOUTH DAKOTA—Pierre, April 22, 1919. This species ranges throughout the eastern portion of the United States, south into Mexico and west to Colorado.

Gerris incurvatus Drake and Hottes.

OREGON—Corvallis, June 26, 1926, C. J. Drake. BRITISH COLUMBIA—Victoria, July 4-7, 1926, C. J. Drake. CALIFORNIA—Fresno, June 20, 1926, C. J. Drake. IDAHO—Moscow, April 3, 1913, J. M. Aldrich; Caldwell, July 8, 1926, C. J. Drake. MONTANA—Bozeman, 1906 and Gallatin Co., June 3, 1902, R. A. Cooley. *G. incurvatus* is very common in the northwest and along the Pacific coast. Its known range extends east into Illinois.

Gerris incognitus Drake & Hottes.

OREGON—Corvallis, June 26, 1926, C. J. Drake. CALIFORNIA—Fresno, June 20, 1926, C. J. Drake. IDAHO—Moscow, April 1913; Caldwell, July 9, 1926, C. J. Drake. MONTANA—Gallatin Mtns., August 25, 1925, and Big Fork, August 20, 1912, R. A. Cooley. This is one of the most common gerrids in the northwest. It has been frequently confused in collections with both *G. marginatus* and *G. gillettei*.

Gerris comatus Drake and Hottes.

NEW YORK—Ithaca, August 26, 1890, H. E. Summers; Buffalo, E. P. Van Duzee. ILLINOIS—Algonquin, November 2, 1908. MINNESOTA—North Branch, June 17, 1922, C. E. Mickel; Mora, June 16, 1922, and Detroit, July 2, 1922, W. E. Hoffman. IOWA—Albia, Ames, Atlantic, Cedar Falls, Clear Lake, Elkader, Lovilia, Ft. Dodge, McGregor, Mason City, Oelwein, Red Oak, and Webster City, June-August, 1927, Harris and Johnston. SOUTH DAKOTA—Brookings, April 28, 1921, H. C. Severin. NEBRASKA—Big Springs, August 26, 1925, C. J. Drake. COLORADO—Dolores, Garrison, Hudson, Mesa Verde National Park, Pagosa Springs, South Fork, Wray and Veta Pass, August, 1925, C. J. Drake. MONTANA—Bozeman, August, 1913, R. A. Cooley. *G. comatus* has been confused in practically every collection and in the literature with *G. marginatus* Say. It is one of the most common species in eastern Canada and United States, occurring from Colorado to the Atlantic Coast.

Gerris comatus var. *mickeli* Drake and Hottes.

A female was taken in a swamp at Corvallis, Oregon, June 26, 1926, and another at Wray, Colorado, August 4, 1925, by C. J. Drake. These two specimens and the types from Minnesota are brachypterous. The male is unknown. This variety differs from typical *G. comatis* in having longer and more numerous hairs on the connexival spines and a stripe along each side of the pronotum in front. Male specimens may prove it to be a distinct species.

Gerris marginatus Say.

TENNESSEE—Knoxville, June 13, 1891, H. E. Summers. NORTH CAROLINA—Southern Pines, March 2, 1916. OHIO—Delaware, July 12, 1916, C. J. Drake. NEW YORK—Buffalo, 1890, E. P. Van Duzee. IOWA—Ames, Albia, Atlantic, Burlington, Cedar Falls, Clear Lake, Donnelson, Elkader, Farmington, Ft. Dodge, Ft. Madison, Jewell, Mason City, McGregor, Oelwein, and Red Oak, June-August, 1927, Harris and Johnston. KANSAS—Lawrence. MINNESOTA—Rochester, June 15, 1922, C. E. Mickel. COLORADO—Wray and Mesa Verde National Park, August, 1925, C. J. Drake. MISSISSIPPI—Charleston, August 31, 1925, H. M. Harris. WEST VIRGINA—Morgantown, July, 1927, L. E. Dills. TEXAS—Weslaco, July 17, 1927, M. McPhail. *G. marginatus* probably occurs in every state in the union. Several species have been confused with it in literature.

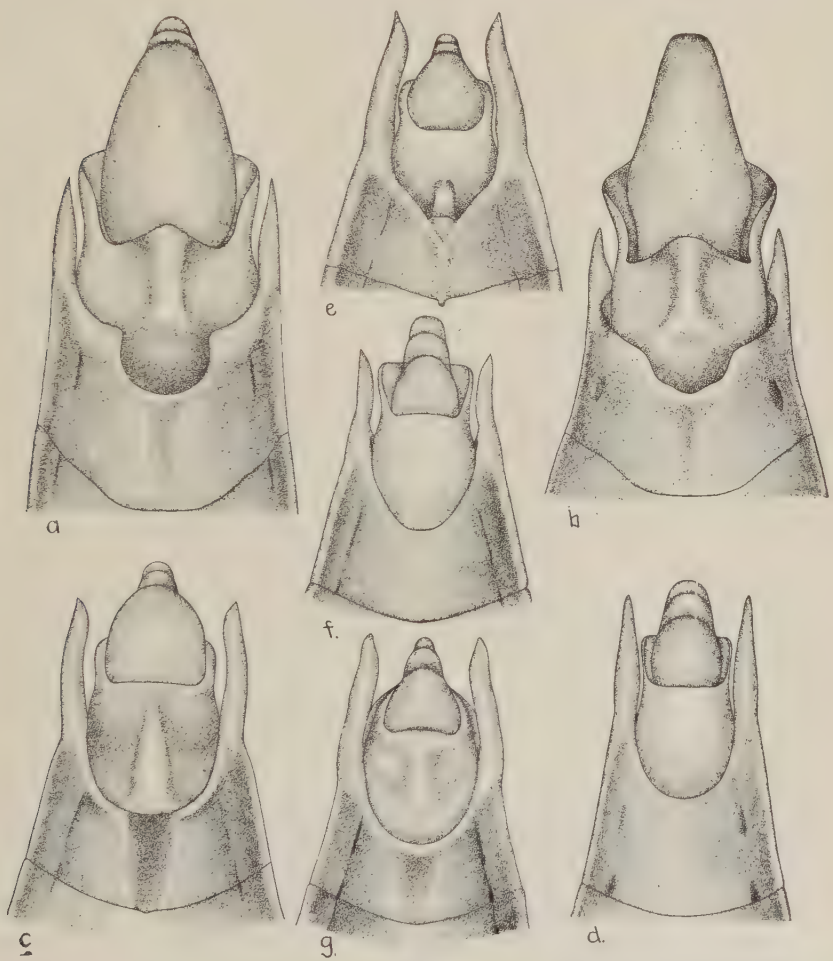


Fig. 1. Ventral aspect of male genitalia of the larger species of *Gerris*. a, *Gerris remigis* Say; b, *G. nyctalis* D. & H.; c, *G. nebularis* D. & H.; d, *G. notabilis* D. & H.; e, *G. uhleri* D. & H.; f, *G. rufoscutellatus* Latr.; g, *G. conformis* Uhl. (Drawn by Miss Kathleen Doering).

Gerris pingreensis Drake and Hottes.

COLORADO—Pingree Park and Estes Park, August 20-24, 1925, C. J. Drake. IDAHO—T. D. A. Cockerell. This species is common in the ponds and lakes in the high altitudes of the Rocky Mountains.

Gerris alacris Hussey.

OHIO—Hocking Co., May 10, 1916, C. J. Drake.

Gerris gillettei Lethierry and Severin.

COLORADO—Dolores, Ft. Garland, Garrison, Pagosa Springs, Pingree Park, Trinidad, South Fork, Wray and Veta Pass, August, 1925, C. J. Drake. MONTANA—Bozeman, June 1, 1924, R. A. Cooley. CALIFORNIA—Fresno, June 20, 1926, C. J. Drake. TEXAS—Rock Island, July 10, 1922, Grace O. Wiley. UTAH—Saltair, July 5. This is a western species and is found in the Rocky Mountain states and along the Pacific slope.

Gerris buenoi Kirkaldy.

NEW YORK—Rochester, September 1, 1890; Buffalo, September, 1886, E. P. Van Duzee. ONTARIO—Ottawa, April 26, 1922, C. H. Curran. MASSACHUSETTS—Forest Hills, November 1, 1915, H. M. Parshley. IOWA—Ames, Cedar Falls and Mt. Pleasant, July 14, 1927, Harris and Johnston. SOUTH DAKOTA—Brookings, April 28, 1921, H. C. Severin. COLORADO—Ft. Collins, August 23, 1925, C. J. Drake. OREGON—Corvallis, June 26, 1926, C. J. Drake. BRITISH COLUMBIA—Victoria, July 4-7, 1926, C. J. Drake. *G. buenoi* is a transcontinental species and is very common in southern Canada and northern United States.

Gerris notabilis Drake and Hottes. (Fig. 1, d).

CALIFORNIA—Fresno, June 20, 1926, C. J. Drake. WASHINGTON—San Juan Island, July 2, 1926, C. J. Drake. IDAHO—Moscow, 1913. MONTANA—Shields River, July 17, 1925. COLORADO—Dolores, Garrison, Mesa Verde National Park, South Fork, August, 1925, C. J. Drake. IOWA—Ames, July, 1925, C. J. Drake. This is a very common species in the Rocky Mountains and along the Pacific coast. It ranges as far east as central Iowa. The much longer legs and the different genital characters separate it from *G. rufoscutellatus*.

Gerris canaliculatus Uhler.

FLORIDA—Gainesville, July 14, 1918, C. J. Drake. MISSISSIPPI—Charleston, September 9, 1925, H. M. Harris; Natchez, September 8, 1924, H. M. Harris; Vicksburg, Port Gibson, Woodville, McComb and Agr. College, July, 1921, C. J. Drake. ARKANSAS—Little Rock, August 30, 1926, H. M. Harris. OHIO—Rockbridge, September 30, 1916, C. J. Drake. NEW YORK—Ithaca, August, 1890, H. E. Summers; Syracuse, 1917-21, C. J. Drake. ILLINOIS—Oaktown, August 15, 1905; Pulaski, July 10, 1907; Dubois, August, 1913.

Gerris argenticollis Parshley.

Sugar Grove, Ohio, July 28, 1916, C. J. Drake. Agr. College, Mississippi, April, 1916, R. W. Harned. Chicago, Illinois, W. A. Gerhard.

Gerris mexicanus Champion.

Two specimens, Cuernavaca, Mexico, May 15, 1898.

Gerris cariniventris Champion.

Tegucigalpa, Honduras. Four specimens, which agree with two of Champion's cotypes before us.

Tenagogonus hesione Kirkaldy.

OHIO—Columbus, Rockbridge, and Buckeye Lake, 1916, C. J. Drake. MISSISSIPPI—Summit, September 4, 1926, and Charleston, September 8, 1926, H. M. Harris; McComb, Fayette, and Vicksburg, July, 1921, C. J. Drake. FLORIDA—Gainesville, May-July, 1921, C. J. Drake. TEXAS—Bryan, October 25, 1927, H. G. Johnston. ILLINOIS—Havana, October 4, 1910; Dubois, August 13, 1917. The long-winged form is common in Mississippi and Florida but uncommon in the northern states. One winged example from Columbus, Ohio, is at hand.

Tenagogonus hyalinus Fabricius.

MEXICO—Minatitlan, February 1, 1892, H. Osborn. WEST INDIES—Grenada, September 25, 1891, H. E. Summers.

Tenagogonus quadrilineatus Champion.

MEXICO—Colima, L. Conradt. HONDURAS—Tegucigalpa, July 14-19, 1917, H. G. Dyer.

Trepobatopsis denticornis Champion.

TEXAS—Clifton, May 30, 1907. This is the first known record of this insect occurring in the United States. Another specimen from Cantarina, Monterey, Mexico, April 10, 1910, is before us. It has the wings broken off.

Trepobates floridensis, n. sp.

Distinctly smaller than any other known species of the genus. Body above black, an elongate spot on either side and an interrupted line on posterior margin of mesonotum, a small spot on each side and more or less of basal margin of pronotum, a line on each side of head above the eyes and the posterior margin between these lines yellowish brown. Body beneath and a broad stripe on each side of mesonotum yellowish. Rostrum reaching a little beyond anterior coxæ, dark brown, the basal segment yellowish. Antennæ dark brown, yellowish at base segment I long, slightly curved, subequal to II and III conjoined; II very slightly shorter than III.

Pronotum practically twice as broad as long, impressed on each side of the disc. Mesonotum broadly and rather uniformly impressed along the median line, the posterior margin truncate. Legs much shorter and slenderer than in *T. pictus* Uhl., dark brown; the anterior tibiæ strongly curved, slenderer at base and apex. Connexivum moderately broad, concolorous. Abdomen above without spots. Length 2.5 mm.; width 1.0 mm.

Holotype, apterous male, East Florida, collection of authors. The much smaller size and the shorter and slenderer legs and antennæ separate this species from any of its congeners. The intermediate legs and the second antennal segment, as in *T. pictus*, are without long hairs. The proportional lengths of the antennal segments in these two species are: *pictus*, I:II:III:IV—80:43:49:47; *floridensis*, 50:24:26:(missing).

Rheumatobates tenuipes Meinert.

MARYLAND—Glen Echo, September 8, 1893. MISSISSIPPI—Charleston, September 8, 1926, H. M. Harris. FLORIDA—Gainesville, J. M. Watson, TENNESSEE—Knoxville, June 5, 1890, H. E. Summers.

Rheumatobates trulliger Bergroth.

TENNESSEE—Knoxville, June 15, 1890, H. E. Summers. MISSISSIPPI—Charleston, September 7, 1925, H. M. Harris; Shipman, August 2, 1921, C. J. Drake. A wingless male and female from Shipman, Miss., have been compared with the type of *R. trulliger* for the authors by the late Dr. E. Bergroth.

Rheumatobates hungerfordi Wiley.

TEXAS—Weslaco, July 17, 1927, M. McPhail; Bryan, October 25, 1927, H. G. Johnston.

Rheumatobates rileyi Bergroth.

MISSISSIPPI—Charleston, September, 1925 and 1926, H. M. Harris. FLORIDA—Gainesville, J. R. Watson. OHIO—Cuyahoga Co., and Berea, July, 1914, C. J. Drake. IOWA—Ames, Albia, Cedar Falls, Oelwein and Mt. Pleasant, June-August, 1927, Harris and Johnston. ILLINOIS—Havana, July 7-13, 1917.

Mesovelia cryptophila Hungerford.

IOWA—Wapello, August 5, 1926, H. M. Harris. MISSISSIPPI—McComb, September 8, 1924, H. M. Harris.

Microvelia oreadis, n. sp.

Elongate, narrow, fusiform; dark fuscous black, the sides of connexiva a little lighter. Pronotum with a broad transverse rufofulvous band in front, the abdominal tergites each with a pale brownish spot. Head with the usual, shiny, impressed median line and blackish spots above the eyes. Antennæ about one-half as long as body, pilose, with a few scattered setæ, dark brownish black; segment I paler and tinged at base with testaceous, stoutest, slightly curved; the proportional lengths of segments:—I:II:III:IV = (male) 17:14:19:25, (female) 17:18:25:30. Rostrum stout, brownish testaceous, the terminal segment blackish, reaching a little beyond the middle of mesonotum.

Pronotum short, coarsely pitted behind, the basal margin slightly emarginate. Mesonotum about half as long as pronotum. Legs brownish, the coxæ, trochanters, and tibiæ beneath lighter; tibiæ clothed with numerous long setæ. Connexivum very broad, broader in female than in male. Abdomen with the last tergite truncate at apex in male, rounded in female. Body beneath flattened, yellowish to dark brown. Length (male) 2.21 mm.; (female) 2.78 mm.; width (male) .79, (female) .93 mm.

Holotype, apterous male, and *allotype*, apterous female, Estes Park, Colorado, August 24, 1925. *Paratypes* (253 specimens), taken with type, also at Fort Collins, Colorado, August 23, 1925, Placerville, Colorado, August 15, 1925, and Dolores, Colorado, August 15, 1925, C. J. Drake, collector. Types in collection of authors. Paratypes in collections of Iowa State College, University of Kansas, U. S. National Museum, British Museum of Natural History, H. H. Knight and the authors.

In many of the specimens some of the dorsal segments of abdomen and connexiva bear flattened silvery hairs which are grouped in patches. This species is perhaps most closely related to *M. setipes* Champion. However, it is slightly smaller and the setæ like hairs on the tibiæ are

more numerous. The proportional lengths of the antennal segments of the males of *M. oreadis* are also much different.

Microvelia irrasa, n. sp.

Oblong, rather densely clothed with very long erect hairs; black, the pronotum with a broad transverse orange band. Head with an impressed median black line, the vertex with a prominent pit on each side above the eyes. Antennæ long, slender, dark fuscous, the basal portion of segment I and all of II and III lighter, the proportional length of the segments:—I:II:III:IV = 45:38:42: 39; segment I moderately stout, distinctly curved, III slenderer than II, IV fusiform. Rostrum stout, apical segment black, surpassing intermediate coxæ.

Pronotum transverse, shallowly and broadly emarginate behind, slightly shorter than metanotum and about two-fifths the length of mesonotum. Mesonotum strongly narrowed posteriorly, truncate behind. Legs yellowish, somewhat tinged with brown, the tarsi black; clothed with dense whitish pile with numerous extremely long yellowish hairs. Connexivum broad. First genital segment deeply emarginate behind, strongly and roundly excavated beneath. Length, 4.14 mm.; width, 1.5 mm.

Holotype, apterous male, Orizaba, Mexico, January 17, in Drake collection. *Paratypes*, 2 males, taken with type. The female and the winged form are unknown.

Aside from the other structures, the larger size, extremely long hairs clothing body and legs, and the structure of antennæ and thorax separate this species from its congeners. It has somewhat the general aspect of a *Rhagovelia*, but belongs to the group of species of *Microvelia* containing *M. americana* Uhler. The hind femora of the male bears along the distal half of the inner surface several spines two or three of which are strongly curved. In the holotype the hind femora are slightly stouter and the spines are shorter than in the paratypes; also in the holotype the spines on the right femora are slightly more developed than those on the left.

Microvelia fontinalis Bueno.

Specimens are at hand from the following localities: OHIO—Berea, July 16, 1914, C. J. Drake. TENNESSEE—Knoxville, June 27, 1891, H. E. Summers. VIRGINIA—near Plummer's Island, Maryland, October 30, 1921, H. S. Barber. IOWA—Burlington, August 4, 1926, H. M. Harris. COLORADO—Wray, August 4, 1925, C. J. Drake.

This species has heretofore been recorded in literature from Ohio, New York, New Jersey, Indiana and Michigan. One of the Tennessee specimens is winged, this form previously being unknown. (*Morphotype*, in the collection of H. E. Summers at Iowa State College.)

Macropterous form: Brownish fuscous with two elongate white spots at base of elytra, the pronotum with a transverse orange or fulvous stripe in front. Pronotum strongly developed, coarsely pitted, carinate down the middle, the apex broad and sub-truncate; humeri large and prominent. Hemelytra extending to tip of abdomen, dark brown with two of the cells beyond the basal spots tending to become more or less whitish. Length 2.5 mm.; width, .93 mm.

Microvelia hinei Drake.

Originally described from Ohio, *M. hinei* has since been recorded from New York, Massachusetts, Michigan, and Florida. The authors possess specimens from the following additional localities: ARKANSAS—Little Rock, August 30, 1926, H. M. Harris. MISSISSIPPI—Charleston, Crowder, Fayette, McComb, Ocean Springs and Woodville, various dates (C. J. Drake and H. M. Harris). DISTRICT COLUMBIA—Washington, August 13, 1889, O. Heidemann, and December 30, 1915, W. L. McAtee. IOWA—Wapello, August 16, 1926, H. M. Harris.

Microvelia borealis Bueno.

Heretofore known from Maine, New York, New Jersey, Connecticut, Massachusetts, Indiana, Michigan, Illinois and Kansas. To these may be added the following additional localities: OHIO—Lake Pippin, Sugar Grove, Rock Bridge, Delaware, and Columbus, June-August, 1916, C. J. Drake. IOWA—Ames, Wall Lake, Burlington, and Farragut, summers of 1924-1927, C. J. Drake and H. M. Harris. MISSISSIPPI—Port Gibson, Vicksburg, and Woodville, July, 1921, C. J. Drake; Charleston, and Crowder, August, 1925, H. M. Harris. FLORIDA—Gainesville, June 9, 1918, C. J. Drake. NEBRASKA—Fremont, August 30, 1925, C. J. Drake. OREGON—Corvallis, June 30, 1926, C. J. Drake. CANADA—Ottawa, Quebec, September 7, 1890.

Microvelia austrina Bueno.

Described from Raleigh, N. C., and heretofore known only from there. Specimens are at hand from: MISSISSIPPI—Charleston, September 7, 1925, H. M. Harris; and TENNESSEE—Knoxville, June-July, 1891, H. E. Summers. Many of the Tennessee specimens are winged. (*Morphotypes* in the Summers' collection at Iowa State College).

Macropterous form: Pronotum strongly developed, dark brown with a large transverse fulvous spot in front, coarsely pitted, the humeri very prominent. Hemelytra extending to tip of abdomen, dark brown, the veins fairly distinct. Length, 1.92-2.14 mm.; width, .61-.64 mm.

Hydrometra martini Kirkaldy.

OHIO—Columbus, Tiffin, Malta, Prentice, and Zanesville, July-August, 1916, C. J. Drake. FLORIDA—Gainesville, July 7, 1918, C. J. Drake. MISSISSIPPI—Port Gibson, Agr. College, Woodville, and McComb, July, 1921, C. J. Drake; Charleston, September 7, 1925, H. M. Harris. NEW YORK—Ithaca, August 7, 1895. OREGON—Corvallis, June 26, 1926, C. J. Drake. This species has heretofor been doubtfully recorded from the Pacific Slope. More than a hundred specimens were taken in a swamp at Corvallis, Oregon.

Published October 31, 1928.